Inasmuch as these surface-waves could be recognised at a distance of a few hundred miles from their origin, it was naturally assumed that the movements resulting from unusually large disturbances which not unfrequently travel to their antipodes should exhibit the same undulating characteristics. Some support to this view was found in the large movements of delicately adjusted horizontal pendulums, the movements recorded in the traces from magnetographs and barographs, whilst the movements occasionally noted of the bubbles in astronomical levels or the shifting of a star in a telescopic field, together with other phenomena, tended to strengthen the view that the large waves in seismograms represented actual earth tilting. Although I do not yet see how certain of these phenomena can be explained on the assumption of purely horizontal movements, especially when the period of these may exceed twenty seconds, in a British Association Report (September 1900) I published observations indicating that the surface-wave theory met with so many objections that it could not be generally applied. One objection rested upon observations indicating that the velocity of propagation of these waves did not appear to be constant.

Although for certain practical purposes it may be assumed that the arcual velocity of these movements is 3 km. per second, there is evidence to show that they have an initial velocity of about 2 km., whilst their quadrantal velocity approaches 4 km. per second. Dr. C. G. Knott, who has done so much for practical and theoretical seismology, at once pointed out that any change in speed was a serious stumbling-block to the surface-wave theory, which he had always regarded with disfavour. As an alternative, in the *Scottish Geographical Magazine* (January 1899), and in other publications, he showed that the observations relating to speed could be satisfied by the assumption of a distortional mass wave, and it is to the outcrop of such waves to which Dr. Knott looked for the explanation of the large movements of the seismograph.

This hypothesis, however, does not tell us whether the movements actuating a seismograph are vertical, horizontal or angular. Many years ago Dr. A. Cancani pointed out that if these waves represent tilting, from the angular values of the same and the length of the waves which can be deduced from their period and velocity, then on the assumption of simple harmonic motion the height of such waves could be calculated.

Such heights have been frequently estimated, but in the British Association Report (September 1900), p. 83, attention is called to the fact that as these represent accelerations not unfrequently 1/50 of gravity, the existence of these vertical displacements is doubtful, and an experiment to confirm or modify our views was in progress.

The "experiment" referred to consisted in observing the movements of a pointer attached to the earth relatively to the pointer of a clinograph similar to, but much larger than, the one described above. Any relative movement of these pointers would be shown by the displacement of a spot of light reflected from a mirror hung by a bifilar attachment to the two pointers. Subsequently the record was made mechanical. With the first installation 1 mm. deflection $=0''.7$, and in the second $6''.0$. Although several large earthquakes occurred, no record was obtained.

In another experiment slight records were obtained from the photographic registration of a spot of light reflected from a mirror which was caused to rotate by the rising or falling of a weight attached to an ordinary spiral spring. The length of the spring under the influence of its own weight is 9·5 inches. With a load of 1 lb. 8 ozs. its length was 3 feet 5 inches and its natural period 2 seconds.

The earthquake of October 9, 1900, caused ripples on the photogram each about ·5 mm. in range, which would correspond to a change that might have been produced by increasing and decreasing the load by 1/700 part of itself. The period of motion was approximately 6·5 minutes, which corresponded with the period of maxima in the large waves as in an ordinary seismogram.

The Venezuela earthquake of October 29 gave deflections of half the above and with periods of about 7 minutes. Other earthquakes caused somewhat similar movements, but usually nothing more than slight blurs upon the photographic traces were to be seen.

The records from the clinometer indicate that earth tilting has not been measurable by the instrument employed, whilst the records from the spiral spring show that there is a possibility that vertical motion may exist, but if it does it is exceedingly minute.

The general inference is that the large waves due to earthquakes originating at a distance, whether they are surface waves or mass waves, actuate horizontal pendulums by horizontal displacements of the ground, rather than by the tilting of the same.

The distinguished seismologist, Dr. F. Ōmori (see "Publications of the Earthquake Investigation Committee," Tokyo, No. 5, January, 1901), and Dr. Wilhelm Schlütter (see his "Inaugural Dissertation," Göttingen, 1901) have recently expressed similar views. Dr. Omori's objection to the surface-wave theory is based partly upon the impossibility of accepting the vertical accelerations calculated on the assumption that seismographs have acted as clinometers, a view already expressed by Dr. C. G. Knott, Dr. C. Davidson, myself and other physicists, and partly upon the observations he has made showing that the amplitude of seismograms depends upon the multiplication of the writing pointers rather than the sensibilities of seismographs to tilting.

Dr. Schlütter's conclusions are arrived at from the fact that some twenty earthquakes failed to yield any record on the photograms obtained from a "klinograph," which in general arrangement is not unlike those already referred to, but very much more sensitive. The care which Dr. Schlütter took to ensure accuracy can only be realised by reference to his memoir, which, as an essay relating to this class of investigation, stands *facile princeps*.

The general conclusions arrived at are that for severe earthquakes with a near origin, surface earth-waves may be marked. To record these clinographs are required, and the entries in registers referring to the same should be correspondingly modified. In designing instruments to record earthquakes with a distant origin, the principle introduced by Prof. J. A. Ewing into seismometry relating to steady points must be carefully observed, and in our registers we must regard our entries as referring to displacements which are horizontal rather than angular.

J. MILNE.

ELEMENTARY MEDICAL EDUCATION.

WE have received a memorial to the General Medical Council concerning the relegation of the teaching of elementary chemistry, physics and biology to the school, as distinguished from the medical school. The memorial is signed by a number of men of science, teachers of botany, zoology, chemistry or physics. In the opinion of these gentlemen the above subjects should be permanently retained as part of the medical curriculum proper, and their relegation to the schools is, according to them, likely to have a prejudicial influence upon medical education. The most powerful argument, so far as we can see, brought forward in support of this hypothesis is that the schoolboy, as distinguished from the medical student, is intellectually less capable of grasping those scientific generalisations without which the teaching of the elementary scientific subjects above named would not be productive of the desired result, viz. the

development of a truly scientific mind. This as a general statement may perhaps be admitted, though it must be at once pointed out that the difference between the intellectuality of a schoolboy aged sixteen and of a medical student aged seventeen *qua* age is not great, if it exists at all, and postponement of the teaching in these subjects beyond seventeen or eighteen would certainly be impossible.

All are agreed that the attainment of scientific methods of observation and reasoning is a quality of the first importance to the future medical man, especially as the ultimate result of his education, viz. the practice of medicine or surgery, is essentially an inexact science, one in which the data for the formulation of conclusions are extraordinarily inconstant and ephemeral, often demanding for their detection the most trained observation, and for their elucidation the most careful reasoning.

The medical curiculum is, however, filled to the bursting, and unless we want the student to emerge from it partially insane, some depletion must take place. It should also be remembered in this connection that intellectual attainments are not the sole requirements of the medical man. Manipulative skill, and, further, physical training, rendering him capable of enduring physical strain, are also practically essential. This and the fact that the actual subject-matter of medicine and surgery has increased enormously during the last few years, not merely in the direction of biology, chemistry and physics, but also in that of the actual accumulation of clinical fact, render the intellectual burden to be laid, according to the present arrangements, upon the medical student more than he can bear.

Further, the student of medicine stands in a peculiar position with regard to chemistry, biology and physics, for while it is not to be denied that a clear understanding of them is necessary to his education, yet nevertheless it is not only from them that he receives training in the methods of pure science. After having mastered the essential principles of these he still spends two years or more in the study of science, preparatory to entering upon the subject-matter proper of his profession. The first, second, and often third year are devoted to physiology, anatomy and pharmacology ; all subjects which tend, not only to store the mind with fact, but also to educate it in scientific method. If the training of the medical student in scientific method depended solely upon the teaching in chemistry, physics and biology, referred to in the memorial we have received, we confess that we should view with concern the relegation of these subjects to the schools ; clearly, however, this is not the case, and since something must be done to relieve the overwhelming mass of knowledge to be acquired by the average student in five short years, we feel that the General Medical Council are acting wisely in demanding more of the schools. It is, however, to be hoped that it will see that the school teaching in these subjects is efficient and that the student comes up to the medical school thoroughly grounded in them.

F. W. T.

SUMMARY OF PROGRESS OF THE GEOLOGICAL SURVEY.

THE publication of the Summary of Progress of our British Geological Survey for the year 1900 has evidently been delayed, for we have long ago received and noticed the annual reports of the Canadian and Indian Geological Surveys, and we have likewise referred to the retirement of Sir Archibald Geikie, who in this publication issues his last official report on the work which for so many years he directed. It is a report which, as usual, provides material of sufficient diversity to interest students of all branches of geology. Those who cultivate a knowledge of the oldest rocks will find ample material for consideration in the accounts of the Moine schists and Muscovite-biotite gneiss of Ross-shire, and in the fuller descriptions of the Dalradian or younger schists of the central Scottish Highlands. Thrust-planes and the phenomena of thermo-metamorphism and contact-metamorphism are dealt with, as well as the relations of the schists to the older and newer granites and other igneous rocks. Outside the great granite masses of Lochnagar and the Cairngorm Mountains there is an exceptional extension of cordierite-hornfels, due to the alteration of aluminous black schist ; while impure limestones are characterised by the development of silicates, of garnet, idocrase, malacolite and wollastonite. Special attention is drawn to the distinction which it is sought to make between the band of schists known to the surveyors as the "Green beds," originally sedimentary rocks, and the Epidiorites, which occur as sills of much-foliated igneous rock. The "Boulder bed" also forms an important horizon in the mass of Dalradian schists. In some places it affords evidence of having been in part a true conglomerate before any movement such as shearing or crushing took place ; elsewhere it appears as a crush conglomerate, or it presents an "augen-structure" on a gigantic scale. In Ireland attention was mainly given to the Silurian rocks of Waterford and Wexford and their associated intrusive and volcanic rocks, which are described in some detail. In the south-west of England work was carried on among the Lower Devonian rocks of Looe in Cornwall and on the various subdivisions of the "Killas" near Falmouth, the "greenstones," and the granite of Penryn.

In the great South Wales coal-field work has been vigorously prosecuted in the district around Swansea. There the Old Red Sandstone and the Lower Carboniferous rocks are of especial interest in connection with their Devonshire equivalents, and it is of the highest interest to learn that radiolarian chert has been recognised in the Gower series described long ago by De la Beche and compared by him with the Coddon Hill beds of North Devon.

The Gower series occurs on top of the main mass of Carboniferous Limestone and belongs to the group of "Upper Limestone shales." These are represented on the north crop of the South Wales coal-basin by "Rottenstone shales," in which also bands of radiolarian chert have been discovered. The upper part of the Gower series consists of a mass of dark shales in which *Goniatites* (*Glyphioceras*) *bilinguis* and *Posidonomya* have been found. At a higher horizon come the hard sandstones and conglomerates of the Millstone Grit. The discovery of these radiolarian cherts is thus an important link in the correlation of the strata in Devonshire and South Wales, for it had been held that the Coddon Hill chert beds might represent the mass of the Carboniferous Limestone. As the work of the Survey proceeds westward further interesting results may be anticipated, especially with regard to comparisons between some of the underlying Lower Carboniferous strata and the Upper Devonian. The Old Red Sandstone has been studied as far north as Caithness, where some of the flags and shales are so bituminous as to become impure oil-shales, while albertite or mineral pitch is found distilled out into the faults and cracks of the strata over large areas. In Argyllshire the relation has been worked out between some of the younger granites of Ben Cruachan, Blackmount and the Moor of Rannoch, and the vents of the Lorne volcanic region. As these vents belong to the time of the Lower Old Red Sandstone, the granites which invade them probably belong to the remarkable series of granite extrusions which in the British Islands intervened between the close of the Upper Silurian and the beginning of the Upper Old Red Sandstone periods.

Details are given of the various coal-seams and of